

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner
 US Department of Commerce
 United States Patent and Trademark
 Office, PCT
 2011 South Clark Place Room
 CP2/5C24
 Arlington, VA 22202
 ETATS-UNIS D'AMERIQUE
 in its capacity as elected Office

Date of mailing (day/month/year) 17 May 2001 (17.05.01)	
International application No. PCT/IE00/00106	Applicant's or agent's file reference 30883WO
International filing date (day/month/year) 13 September 2000 (13.09.00)	Priority date (day/month/year) 13 September 1999 (13.09.99)
Applicant YOUNG, George	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:
 29 March 2001 (29.03.01)

☐ in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was
☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer Pascal Piriou Telephone No.: (41-22) 338.83.38
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PATENT COOPERATION TREATY

PCT

From the INTERNATIONAL BUREAU

NOTIFICATION CONCERNING
SUBMISSION OR TRANSMITTAL
OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

To:

O'CONNOR, Donal, H.
Cruickshank & Co.
1 Holles Street
Dublin 2
IRLANDE

Date of mailing (day/month/year) 15 November 2000 (15.11.00)	
Applicant's or agent's file reference 30883WO	IMPORTANT NOTIFICATION
International application No. PCT/IE00/00106	International filing date (day/month/year) 13 September 2000 (13.09.00)
International publication date (day/month/year) Not yet published	Priority date (day/month/year) 13 September 1999 (13.09.99)
Applicant COMMERGY TECHNOLOGIES LIMITED et al	

1. The applicant is hereby notified of the date of receipt (except where the letters "NR" appear in the right-hand column) by the International Bureau of the priority document(s) relating to the earlier application(s) indicated below. Unless otherwise indicated by an asterisk appearing next to a date of receipt, or by the letters "NR", in the right-hand column, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).
2. This updates and replaces any previously issued notification concerning submission or transmittal of priority documents.
3. An asterisk(*) appearing next to a date of receipt, in the right-hand column, denotes a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b). In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.
4. The letters "NR" appearing in the right-hand column denote a priority document which was not received by the International Bureau or which the applicant did not request the receiving Office to prepare and transmit to the International Bureau, as provided by Rule 17.1(a) or (b), respectively. In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

<u>Priority date</u>	<u>Priority application No.</u>	<u>Country or regional Office or PCT receiving Office</u>	<u>Date of receipt of priority document</u>
13 Sept 1999 (13.09.99)	S990765	IE	31 Octo 2000 (31.10.00)
06 Dece 1999 (06.12.99)	S991024	IE	31 Octo 2000 (31.10.00)

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer

Magda BOUACHA

Telephone No. (41-22) 338.83.38



07 DEC 2001

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 30883WO	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/IE00/00106	International filing date (day/month/year) 13/09/2000	Priority date (day/month/year) 13/09/1999
International Patent Classification (IPC) or national classification and IPC H05K1/18		
Applicant COMMERGY TECHNOLOGIES LIMITED et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.



2. This REPORT consists of a total of 7 sheets, including this cover sheet.

- ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☒ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand 29/03/2001	Date of completion of this report 05.12.2001
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Batev, P Telephone No. +49 89 2399 7970 

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/IE00/00106

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):
Description, pages:

1-11 as originally filed

Claims, No.:

1-24 as originally filed

Drawings, sheets:

1/8-8/8 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/IE00/00106

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

- ☐ restricted the claims.
☐ paid additional fees.
☐ paid additional fees under protest.
☐ neither restricted nor paid additional fees.

2. ☒ This Authority found that the requirement of unity of invention is not complied and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

- ☐ complied with.
☒ not complied with for the following reasons:
see separate sheet

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

- ☒ all parts.
☐ the parts relating to claims Nos. .

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	4 - 24
	No:	Claims	1 - 3
Inventive step (IS)	Yes:	Claims	12 - 16, 20 - 24
	No:	Claims	1 - 11, 17 - 19

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/IE00/00106

Industrial applicability (IA)	Yes:	Claims	1 - 24
	No:	Claims	none

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

Re Item IV

Lack of unity of invention

It appears that independent claim 20 has no common inventive concept with claim 1, i.e. there are no technical features belonging to the scope of the two claims, on which features an inventive step can be based.

Hence, the application contains two inventions: on one hand, claim 1 defines a PCB assembly, on the other hand, claim 20 defines a magnetic element and claim 22 defines a power converter comprising the magnetic element of claim 20.

Re Item VIII

Certain observations on the international application

It appears that the terminology used is not consistent throughout the description and the claims (Rule 10.2 PCT). More than one term is used for each one of the technical features denoted by reference sign 1: "printed circuit board assembly" and "printed circuit board" ("PCB"), and by reference sign 2: "single layer", "PCB board", "PCB" and "board".

Re Item V

Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following document:

D1: PATENT ABSTRACTS OF JAPAN vol. 1995, no. 03, 28 April 1995 (1995-04-28) & JP 06 350220 A (TOKYO ELECTRIC CO LTD), 22 December 1994 (1994-12-22)

Insofar as the examiner can understand the claims, the following is pointed out:

1. Document D1 (abstract, figure) discloses a printed circuit board assembly comprising a plurality of components 2, 3 having different relative heat generating and heat dissipating properties over the operating range of the PCB, wherein one heat generating component

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/IE00/00106

2 is thermally linked to a heat dissipating component 3.

The subject matter of claim 1 appears, therefore, not new (Article 33(2) PCT).

2. D1 further discloses that the components 2, 3 are thermally linked by a heat conductive coupling material 4 which is in direct contact with one of the components.

Consequently, the subject matter of dependent claims 2 and 3 also appears not new (Article 33(2) PCT).

3. Dependent claims 4 - 11, 17 and 18 do not seem to contain any additional features which in combination with the subject matter of any of the claims to which they refer can be seen as involving an inventive step (Article 33(3) PCT).

4. It seems that the combination of the features of dependent claim 12 with the subject matter of claim 1 is neither known from, nor rendered obvious by, the available prior art. The subject matter of said claim appears to solve the technical problem related to the provision of magnetic element operating at the "optimum temperature" (see p. 3, para. 1 and p. 4, para. 2 and 3, of the description).

Claims 13 - 16 are dependant on claim 12 and as such appear also to meet the requirements of the PCT for novelty and inventive step.

5. It seems that the subject matter of independent claim 20 relates to a magnetic element for use as a heat dissipating element in a PCB assembly.

In view of the available prior art, it appears that claim 20 meets the requirements of the PCT in respect of novelty and inventive step. The same applies to claim 21, which refers back to claim 20.

The subject matter of claims 22 - 24 relates to a power converter comprising the magnetic element of claim 20 and seems, therefore, also new and inventive.

Re Item VII

Certain defects in the international application

Documents US 5973923 and US 5990776 have been published later than the priority date of the present application. Said documents should, therefore, not be indicated in the description as documents reflecting the background art.

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/IE00/00106

In order to meet the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the document D1 should be mentioned in the description and this document should be identified therein.

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

O'CONNOR, D. & SCHUTTE, G.
CRUIKSHANK & CO.
1 Holles Street
Dublin 2
IRLANDE

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY EXAMINATION REPORT (PCT Rule 71.1)

Date of mailing (day/month/year)	05.12.2001
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Applicant's or agent's file reference 30883WO	IMPORTANT NOTIFICATION
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International application No. PCT/IE00/00106	International filing date (day/month/year) 13/09/2000	Priority date (day/month/year) 13/09/1999
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Applicant

COMMERGY TECHNOLOGIES LIMITED et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/	Authorized officer
---------------------------------------	--------------------



European Patent Office
D-80298 Munich
Tel. +49 89 2399 - 0 Tx: 523656 eprmu d
Fax: +49 89 2399 - 4465

Baumann, H

Tel. +49 89 2399-2131



PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 30883WO	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/IE00/00106	International filing date (day/month/year) 13/09/2000	Priority date (day/month/year) 13/09/1999
International Patent Classification (IPC) or national classification and IPC H05K1/18		
Applicant COMMERGY TECHNOLOGIES LIMITED et al.		



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- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☒ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand 29/03/2001	Date of completion of this report 05.12.2001
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Batev, P Telephone No. +49 89 2399 7970 

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/IE00/00106

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, pages:

1-11 as originally filed

Claims, No.:

1-24 as originally filed

Drawings, sheets:

1/8-8/8 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
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- ☐ the description, pages:
- ☐ the claims, Nos.:

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/IE00/00106

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

- ☐ restricted the claims.
☐ paid additional fees.
☐ paid additional fees under protest.
☐ neither restricted nor paid additional fees.

2. ☒ This Authority found that the requirement of unity of invention is not complied and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

- ☐ complied with.
☒ not complied with for the following reasons:
see separate sheet

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

- ☒ all parts.
☐ the parts relating to claims Nos. .

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims 4 - 24
	No:	Claims 1 - 3
Inventive step (IS)	Yes:	Claims 12 - 16, 20 - 24
	No:	Claims 1 - 11, 17 - 19

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. **PCT/IE00/00106**

Industrial applicability (IA) Yes: Claims 1 - 24
 No: Claims none

2. Citations and explanations
 see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
s e separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
s e separate sheet

Re Item IV

Lack of unity of invention

It appears that independent claim 20 has no common inventive concept with claim 1, i.e. there are no technical features belonging to the scope of the two claims, on which features an inventive step can be based.

Hence, the application contains two inventions: on one hand, claim 1 defines a PCB assembly, on the other hand, claim 20 defines a magnetic element and claim 22 defines a power converter comprising the magnetic element of claim 20.

Re Item VIII

Certain observations on the international application

It appears that the terminology used is not consistent throughout the description and the claims (Rule 10.2 PCT). More than one term is used for each one of the technical features denoted by reference sign 1: "printed circuit board assembly" and "printed circuit board" ("PCB"), and by reference sign 2: "single layer", "PCB board", "PCB" and "board".

Re Item V

Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following document:

D1: PATENT ABSTRACTS OF JAPAN vol. 1995, no. 03, 28 April 1995 (1995-04-28) & JP 06 350220 A (TOKYO ELECTRIC CO LTD), 22 December 1994 (1994-12-22)

Insofar as the examiner can understand the claims, the following is pointed out:

1. Document D1 (abstract, figure) discloses a printed circuit board assembly comprising a plurality of components 2, 3 having different relative heat generating and heat dissipating properties over the operating range of the PCB, wherein one heat generating component

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/IE00/00106

2 is thermally linked to a heat dissipating component 3.

The subject matter of claim 1 appears, therefore, not new (Article 33(2) PCT).

2. D1 further discloses that the components 2, 3 are thermally linked by a heat conductive coupling material 4 which is in direct contact with one of the components.

Consequently, the subject matter of dependent claims 2 and 3 also appears not new (Article 33(2) PCT).

3. Dependent claims 4 - 11, 17 and 18 do not seem to contain any additional features which in combination with the subject matter of any of the claims to which they refer can be seen as involving an inventive step (Article 33(3) PCT).

4. It seems that the combination of the features of dependent claim 12 with the subject matter of claim 1 is neither known from, nor rendered obvious by, the available prior art. The subject matter of said claim appears to solve the technical problem related to the provision of magnetic element operating at the "optimum temperature" (see p. 3, para. 1 and p. 4, para. 2 and 3, of the description).

Claims 13 - 16 are dependant on claim 12 and as such appear also to meet the requirements of the PCT for novelty and inventive step.

5. It seems that the subject matter of independent claim 20 relates to a magnetic element for use as a heat dissipating element in a PCB assembly.

In view of the available prior art, it appears that claim 20 meets the requirements of the PCT in respect of novelty and inventive step. The same applies to claim 21, which refers back to claim 20.

The subject matter of claims 22 - 24 relates to a power converter comprising the magnetic element of claim 20 and seems, therefore, also new and inventive.

Re Item VII

Certain defects in the international application

Documents US 5973923 and US 5990776 have been published later than the priority date of the present application. Said documents should, therefore, not be indicated in the description as documents reflecting the background art.

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/IE00/00106

In order to meet the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the document D1 should be mentioned in the description and this document should be identified therein.

"A Printed Circuit Board Assembly"Introduction

5 The present invention relates to a printed circuit board (PCB) assembly of the type comprising a plurality of components having different thermal attributes, namely, of different relative heat generating and heat dissipating properties over the operating range of the PCB. Further, the invention is particularly directed to the provision of PCBs for power conversion use, whether they be for DC to DC or AC to DC power
10 converters.

The majority of power conversion products manufactured today use through-hole mounted components on a PCB with thermal management of the main power dissipating elements achieved either using small heatsinks for individual devices or
15 groups of devices, or using a thermal-conductive mechanical assembly to couple such heat dissipating elements to an external heatsink. This construction technique is not compatible with modern automated manufacturing techniques and is not efficient in the context of volumetric efficiency, with a relatively large volume occupied by power dissipating elements and their heatsinking arrangements.

20 In more recent implementations, as available in many commercial DC-DC medium power converters (up to 100W typically), the windings are integrated into a single multilayer printed circuit board along with the power devices. Such DC-DC converters using integrated planar magnetics are manufactured by Philips or by Synqor Inc. which
25 latter company sells such a converter under the Trade Mark PowerQor™. Typical examples of the terminal coupling for such multilayer printed circuit boards to metallic structures are described in US Patent Specification Nos. 5973923 (Jitaru) and 5990776 (Jitaru). This single board construction technique is very practical for such medium-power DC-DC converters, and one element of the invention relates to
30 techniques for improving heat management within such modules and in their mounting arrangements. These modules up to recently favoured the use of enclosed constructions with the main heat-dissipation elements closely thermally coupled to a base plate, on which a heatsink could be mounted. In many cases, potting in a thermally-conductive material can be used, but this approach is costly, may raise

- 2 -

environmental issues, prevents rework, and can cause stress on components even if a barrier layer is used. Recent practice has begun to favour the use of the single-board open frame construction, facilitated by use of semiconductor devices which can give high operating efficiency, and operating without an external heatsink. This practice
5 makes thermal management within the module and to its environment more critical.

The single-board construction approach requires, however, an excessive area in the case of medium-power converters, particularly in the case of AC-DC converters where the minimum height is effectively determined by items such as electrolytic capacitors
10 which must store energy during the low-voltage parts of the incoming AC waveform. As a result, such converters using the single-board multilayer approach will have poor volumetric efficiency, unless of course several lower power sub-modules are stacked in order to fit within the height constraints imposed by the electrolytic capacitor or a similar bulky element. This approach, however, adds to cost, as switching stages
15 need to be replicated in each module and there is a cost associated with mounting and connecting the sub-modules, as well as the thermal management issues associated with a stack of converter sub-modules as part of an overall power conversion module.

The heat generation of any particular component in, for example, a PCB forming part
20 of a power converter, will vary depending on the operating conditions of the power converter module. Typically, components in which conduction losses dominate will generate more heat at lower input voltage within the specified range, while components in which switching loss or magnetic core loss dominates may generate higher losses at higher input voltages. Thus, the term "heat generating" or "heat
25 dissipating" when referring to the thermal attributes, capacities or properties of a particular component and similarly the qualifications high and low of such terms, refers not to the absolute heat generating or heat dissipating property or ability but simply to its property in that actual specific situation. The heat dissipation property of a component depends largely on its inherent physical make-up. Thus, large bulky
30 metallic components with exposed surfaces will dissipate more heat than those smaller compact components low conductivity materials.

As the designs become more efficient, the operating temperature under which the components operate becomes more critical. While many of the approaches discussed

above and many of the techniques such as, for example, the use of heatsinks such as described in US Patent Specification No. 5075821 (Donnel), appreciate the need to dissipate the heat from some of the components with high heat generating capacity, not enough attention has been paid heretofore to the need to operate the magnetic elements, whether they be conventional magnetic elements or planar magnetic elements at the optimum temperatures. Indeed, many of the ferrite materials used in magnetic elements are often optimised for operation at approximately 100°C and thus, under typical ambient temperature and airflow conditions, the magnetic elements are not operating at the ideal temperature. Many of the power conversion modules of the prior art may cool the semi-conductor power components sufficiently but unfortunately do not operate with the magnetic components at the optimum temperature.

The present invention is directed towards overcoming these and other problems with the prior art and in particular to providing an improved construction of PCB and in particular an improved construction of PCB for use for power converter elements and also to the provision of an efficient magnetic element for use with such PCBs.

Statements of Invention

According to the invention, there is provided a PCB assembly of the type comprising a plurality of components having different thermal attributes, namely, of different relative heating generating and heat dissipating properties over the operating range of the PCB wherein at least one high heat generating component is thermally linked to a high heat dissipating component. In this way, there is an active management of the thermal properties or generation of the PCB which can be particularly effective in power conversion units. The PCB no longer relies on, for example, heatsinks or the like which may be used to dissipate the heat from high heat generating components but utilises the heat dissipating properties of the high heat dissipating components.

30

Preferably, the components are thermally linked by a heat conductive coupling material which may, for example, be in direct contact with one or both of the components. Such heat conductive coupling material can be housed within at least one of the components. It will be appreciated that the advantage of this is

- 4 -

that further heat dissipation will be achieved.

5 The heat conductive coupling material may form additional tracks on the board or additional pads and may form thermal vias with one component on one side of the board and the other components on the opposite side. These would be additional heat conductive tracks or pads, for example, of copper, over and above those used for the conduction of electrical signals. Additionally, a conformable thermally conductive material especially an electrically insulating one can be particularly useful with some components, particularly with non-planar surfaces. Indeed, 10 electrical conductors could be made larger than necessary in certain situations to utilise the heat dissipating properties of them.

Ideally, the components are in close physical proximity with minimal air between them and in one embodiment of the invention, the heat generating component is housed at 15 least partially within the heat dissipating component. Alternatively, the heat dissipating component can be mounted above the heat generating component which heat dissipating component can be a magnetic component. It will be appreciated that the great advantage for the magnetic component is that it is now receiving heat and being heated to allow the ferrite approach optimum thermal operating conditions.

20 In one embodiment of the invention, the magnetic element is a separate magnetic surface mount PCB carrying plug-in legs for mounting on the PCB. This surface mount PCB may be a multilayer circuit board. This latter surface mount PCB may form part of a power converter comprising power semi-conductors on the PCB below the 25 surface mount PCB.

In this latter embodiment, preferably a layer of conformable thermally conductive material fills the space between the bottom of the surface mount PCB and the power semi-conductors.

30 It will be appreciated that ideally the heat dissipating component is thermally linked to more than one heat generating component or indeed more than one heat generating component is thermally linked to more than one heat dissipating component. When the heat generating and dissipating components have different

- 5 -

thermal attributes over the PCB operating range, the choice of components for thermal linking is chosen to provide optimum heat transfer over the PCB operating range. Thus, it is possible that the two different heat generating components would be connected to the one heat dissipating component which heat dissipating component would not, in fact, over the total range of the operation of the PCB, experience any great fluctuation in the amount of heat transmitted thereto for subsequent dissipation.

Further, the invention provides a magnetic element for use with a base PCB comprising a separate magnetic element surface mount PCB carrying plug-in legs for mounting on the base PCB.

In this latter element, the surface mount PCB is a multilayer circuit board.

Further, the invention provides a power converter comprising one of these latter magnetic elements and power semi-conductor elements on the base PCB which preferably are so arranged that the surface mount PCB is above the power semi-conductors.

In this latter power converter, ideally a layer of conformable thermally conductive material fills the space between the bottom of the surface mount PCB and the power semi-conductors.

Detailed Description of the Invention

25

The invention will be more clearly understood from the following description of some embodiments thereof, given by way of example only, with reference to the accompanying drawings, in which:-

30

Fig. 1 is a plan view of a DC-DC power converter of single PCB board construction,

Fig. 2 is a cross sectional view in the direction of the arrows II-II of Fig. 1,

- 6 -

Fig. 3 is a plan view of a heat coupler according to the invention in an E-core;

Fig. 4 is a side view of the heat coupler of Fig. 3,

5

Fig. 5 is a sectional view of a magnetic element surface mount PCB according to the invention mounted on a base PCB,

10

Fig. 6 is a plan view of a partially assembled PCB with power semiconductor components mounted thereon,

Fig. 7 is a sectional view of the PCB of Fig. 6 showing in section a magnetic component mounted thereon,

15

Fig. 8 shows another construction of surface mount PCB according to the invention,

Fig. 9 shows a magnetic component according to the invention, and

20

Fig. 10 illustrates another construction of surface mount PCB according to the invention.

25

Referring to the drawings and initially to Figs. 1 and 2, there is provided a DC-DC power converter module in the form of a PCB assembly 1 comprising a single layer 2 mounting power semi-conductor elements forming high heat generating components 3 and various cores of magnetic material forming heat dissipating components 4. The heat generating components 3 are thermally linked to the heat dissipating components 4 by tracks of a heat conductive coupling material 6. In this embodiment, the tracks 6 actually project into one of the heat dissipating components 4 and lie above or below each of the heat generating components 3 but are electrically insulated therefrom. Suitable insulating materials are used.

30

Referring to Figs. 3 and 4, there is illustrated a heat coupler, indicated generally by the reference numeral 10, having a base portion 11 and fins 12. The base

- 7 -

portion 11 is cranked so as to be coupled thermally closely to a suitable heat generating component by overlying it, but not necessarily touching it, or, if touching it, being insulated therefrom. The tines 12 would then be allowed, for example, to project into the core of a magnetic device, for example, an E-shape core, shown in section and identified by the reference numeral 13. The heat
5 coupler 10 may be a metallic stamping, for example, copper strip, so as to allow the heat to transfer laterally from the heat generating component 3 to the heat dissipating components 4.

10 Referring now to Fig. 5, parts similar to those described with reference to the previous drawings are identified by the same reference numerals. In this embodiment, the PCB board 2 has mounted on it by conventional board interconnect legs 15, a heat dissipating component formed from a separate magnetic surface mount PCB 16 mounting planar ferrite magnetic cores 17. A
15 thermal interface sheet 18 is interposed between the magnetic core 17 and the PCB 2. Thermal vias 19 interconnect the thermal interface sheet 18 with the heat generating components 3, in this case, power semiconductor elements. The thermal vias 19 will be filled with a suitable heat conductive coupling material and similarly so will the thermal interface sheet 18 be manufactured from such a
20 material. The surface mount PCB 16 is a multilayer printed circuit board.

Referring now to Figs. 6 and 7, parts similar to those described with reference to the previous drawings are identified by the same reference numerals. In this embodiment, there is illustrated a heat dissipating component formed from a
25 magnetic core 20 within which are housed heat generating components 3. A thermal connector 21 is also provided to ensure that the high heat generating components 3 are thermally linked to the high heat dissipating components, namely, the magnetic core 20.

30 Referring now to Fig. 8, parts similar to those described with reference to the previous drawings are identified by the same reference numerals. In this embodiment, the surface mount PCB 16 has mounted thereon a plurality of heat generating components 3 and a heat dissipating component formed from the magnetic core 17. Thermal connectors formed again from tracks of thermally

conductive coupling material 6 are provided. This surface mount PCB 16 could effectively be a whole power converter which can then be readily easily mounted on the PCB assembly 1 which effectively forms a base PCB and removed therefrom when maintenance is required.

5

Referring now to Fig. 9, it will be appreciated that obviously heat transfer from one face of a core of magnetic material to the other face of the core magnetic material may be achieved by close alignment of mating surfaces of the magnetic material and the use of appropriate adhesives. As will be appreciated, gaps may be
10 required in the case of inductors and transformers carrying a DC bias current.

Fig. 9 illustrates such a core of magnetic material 30 in which a gap is filled with a heat conductive coupling material, almost certainly a conformable material 31. In this embodiment, the surface mount PCB 16 is a multilayer circuit board which, it
15 will be seen, is mounted above the power generating components 3.

Fig. 10 illustrates an alternative PCB assembly indicated generally by the reference numeral 40, in which parts similar to those described with reference to the previous drawings are identified by the same reference numerals. In this
20 embodiment, the surface mount PCB 16 again mounts the planar ferrite magnetic core now directly over the heat generating components 3 or the PCB 2.

It will be appreciated that the heat generating and heat dissipating components can be linked without necessarily touching. Simply placing them together or one
25 within the other, as illustrated in the drawings, will be sufficient to have good heat conductive coupling. Obviously, the use of any form of heat conductive coupling material is advantageous and in many instances, with uneven and irregular surfaces and components, a conformable heat conductive material will be particularly useful. One particular form of conformable thermally conductive but
30 electrically insulating material is that sold under the trade mark GapPad by Bergquist Corporation. Close alignment of components and the correct choosing of components is all important.

Current ferrite materials have a thermal conductivity of the order of 5 Wm⁻¹ K⁻¹.

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In a typical 100W converter module using two E22 cores with a total face in contact with the printed circuit board on one side of 320mm² and a material thickness of 2.5mm, the thermal impedance is about 2K/W per face. With a typical dissipation of about 10W, the opportunity for achieving very effective cooling of the relatively small power semiconductor devices by using the ferrite material as a heat transmission medium to an external heat dissipation surface is evident.

Various other forms of thermal conductivity can be used such as base plates, heatsinks, etc. as shown in the prior art, however, they do not form any essential elements to the present invention. The arrangement according to the present invention, allows the magnetic elements to be the main heat transfer devices from the power semi-conductor elements.

In the case of a large class of converter modules, typically those with AC input, the practical height is determined by energy storage elements such as electrolytic capacitors. There is a corresponding restriction on the area or "footprint" which can be taken up by the power conversion module. In this case, it may no longer be advantageous on grounds of cost or volumetric efficiency to use a construction technique where the magnetic elements are integrated within a single multilayer board construction.

In this case, it is advantageous to have a base printed circuit board such as illustrated in Fig. 10 in which the power semi-conductor devices are mounted below the magnetic core and use thermal vias to spread the heat within the board and/or to conduct heat to the lower face of the board. The layer count in this board can be two or four, considerably cheaper than the higher layer counts typically used in the case of planar magnetic in-board winding implementations. A low-profile implementation of the magnetic elements, with windings implemented as printed circuit boards or in another low-profile implementation and passing through the window area, may then be mounted over the base printed circuit board in the module. To assist rework and test, it is advantageous to make the magnetic assembly easily removable using a plug and socket arrangement such as illustrated in Fig. 10. In the case of smaller magnetic assemblies, the use of

- 10 -

connectors on the base printed circuit board of the module and the printed circuit board in the magnetic assembly with some retention arrangement may provide a satisfactory mechanical fixing. In the case of larger magnetic structures, such connector arrangements may be augmented by conventional fasteners.

5

When the low-profile magnetic structure is mounted over the base printed circuit board, there are several options in relation to its placement relative to the components below. Close thermal coupling may be achieved between components located immediately below the magnetic material typically employed, with appropriate layers of shielding and/or electrical insulation (typically thermally conductive conformable or compressible material) as required.

10

As an alternative, the magnetic element may be located flush with the base printed circuit board, or over low-height components, and the power semi-conductor elements may be mounted closer to the connectors filling the void that typically exists where the windings protrude beyond the core in most planar magnetic implementations. Opportunities for upward thermal transfer in this case can include use of the connectors and cabling in order to achieve material power dissipation, along with use of heat spreaders to achieve thermal coupling to the magnetic material.

15

20

Measures can be taken as above to improve the face-to-face thermal conductivity of the magnetic material, including careful thermal management at interfaces, as outlined above.

25

Given an E64 core set in EI configuration, and assuming the transmission is only through the ferrite (i.e. no transmission through the winding window), a face-to-face thermal resistance assuming a ferrite thermal conductivity of $4\text{Wm}^{-1}\text{K}^{-1}$ is calculated as 3.7 K/W . This figure can be increased by greater thermal "filing" of the magnetic window and as magnetic materials improve, but is a figure which may achieve a satisfactory cooling effect in the case of many circuit configurations.

30

The invention provides a relatively simple way of improving the thermal

- 11 -

performance of such PCBs by ensuring that the high heat generating components are thermally linked to the high heat dissipating components, whether they be directly coupled by a heat conductive coupling material or simply placed very close to each other. In certain cases, there may even be contact. Additional heat
5 conductive tracks, pads, thermal vias, etc. may all be used. The invention does not envisage limiting in any way the number of layers or tracks making up the PCB.

Also, it will be appreciated that the provision, according to the present invention, of
10 a separate magnetic surface mount PCB carrying plug-in legs for mounting on the base PCB is particularly advantageous. A multilayered circuit board is often used to provide planar magnetics which, if they need to be replaced, can only be replaced with difficulty. Both heat dissipating components and heat generating components will be connected and linked to more than one or other components.

15 It will also be appreciated that it will be necessary to ensure that generating and dissipating components having different thermal attributes over the PCB operating range, are chosen such as to ensure that optimum heat management performance is achieved over the full PCB operating range.

20 It will be appreciated that power converters manufactured in accordance with the invention will be particularly advantageous in use.

In the specification the terms "comprise, comprises, comprised and comprising" or any variation thereof and the terms "include, includes, included and including" or
25 any variation thereof are considered to be totally interchangeable and they should all be afforded the widest possible interpretation.

The invention is not limited to the embodiments hereinbefore described but may be varied within the scope of the claims.

30

CLAIMS

1. A printed circuit board (PCB) assembly (1) of the type comprising a plurality of components (3, 4) having different thermal attributes, namely, of different relative heat generating and heat dissipating properties over the operating range of the PCB, characterised in that at least one high heat generating component (3) is thermally linked to a high heat dissipating component (4).
5
2. A PCB (1) as claimed in claim 1, in which the components (3, 4) are thermally linked by a heat conductive coupling material (6).
10
3. A PCB (1) as claimed in claim 2, in which the heat conductive coupling material is in direct contact with one of the components.
4. A PCB (1) as claimed in claim 2 or 3, in which the heat conductive coupling material (6) is housed within at least one of the components (3, 4).
15
5. A PCB (1) as claimed in any of claims 2 to 4, in which the heat conductive coupling material (6) forms tracks on the board (2).
20
6. A PCB (1) as claimed in any of claims 2 to 5, in which the heat conductive coupling material (6) forms pads on the board (2).
7. A PCB (1) as claimed in any of claims 2 to 6, in which the heat conductive coupling material (6) forms thermal vias (19) with one component (3) on one side of the board (2) and the other component (4) on the opposite side.
25
8. A PCB (1) as claimed in any of claims 2 to 7, in which the heat conductive coupling material (6) is a conformable thermally conductive material.
30
9. A PCB (1) as claimed in any preceding claim, in which the components (3, 4) are in close physical proximity with minimal air gap between them.

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10. A PCB (1) as claimed in any preceding claim, in which the heat generating component (3) is housed at least partially within the heat dissipating component (4).
- 5 11. A PCB (1) as claimed in any preceding claim, in which the heat dissipating component (4) is mounted above the heat generating component (3).
12. A PCB (1) as claimed in any preceding claim, in which the heat dissipating component (4) is a magnetic component.
- 10 13. A PCB (1) as claimed in claim 12, in which the magnetic component is a separate magnetic surface mount PCB (16) carrying plug-in interconnect legs (15) for mounting on the board (2).
- 15 14. A PCB (1) as claimed in claim 13, in which the surface mount PCB (16) is a multilayer circuit board.
15. A PCB (1) as claimed in claim 13 or 14, in which the surface mount PCB (16) forms part of a power converter comprising power semi-conductors on the board (2) below the surface mount PCB (16).
- 20 16. A PCB (1) as claimed in claim 15, in which a layer (18) of conformable thermally conductive material fills the space between the bottom of the surface mount PCB (16) and the power semi-conductors.
- 25 17. A PCB (1) as claimed in any preceding claim, in which the heat dissipating component (4) is thermally linked to more than one heat generating component (3).
- 30 18. A PCB (1) as claimed in any preceding claim, in which the heat generating component (3) is thermally linked to more than one heat dissipating component (4).
19. A PCB (1) as claimed in claim 17 or 18, in which when the heat generating

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and dissipating components (3, 4) have different thermal attributes over the PCB (1) operating range, the choice of components (3, 4) for thermal linking is chosen to provide optimum heat transfer over the PCB (1) operating range.

5

20. A magnetic element for use with a PCB assembly (1) comprising a separate magnetic element surface mount PCB (16) carrying plug-in legs (5) for mounting on the board (2) of the PCB assembly (1).

10

21. A magnetic element as claimed in claim 20, in which the surface mount PCB (16) is a multilayer circuit board.

22. A power converter comprising the magnetic element as claimed in claim 20 or 21 and power semi-conductor elements on the PCB assembly (1).

15

23. A power converter as claimed in claim 22, in which the surface mount PCB (16) is arranged above the power semi-conductor elements.

20

24. A power converter as claimed in claim 23, in which a layer of conformable thermally conductive material (6) fills the space between the bottom of the surface mount PCB (16) and the power semi-conductors.

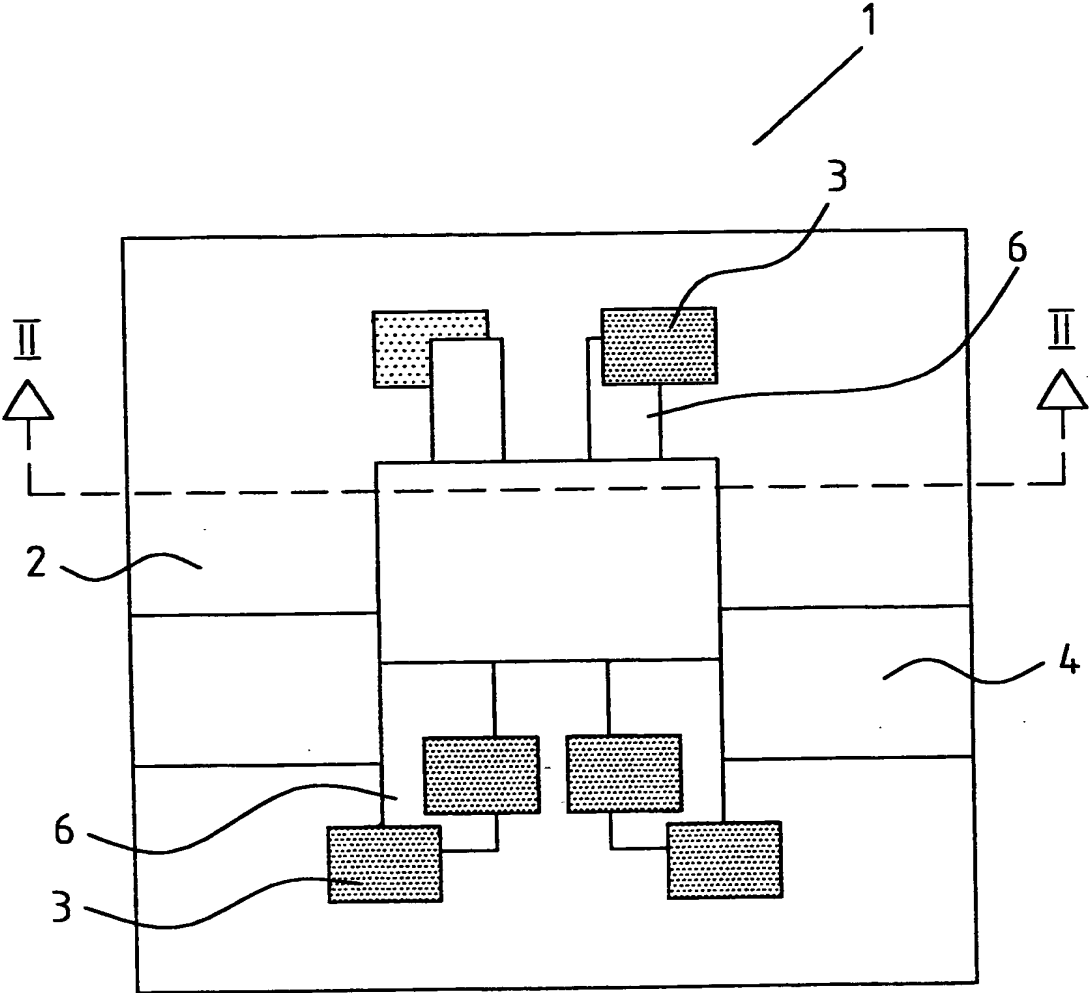


Fig. 1

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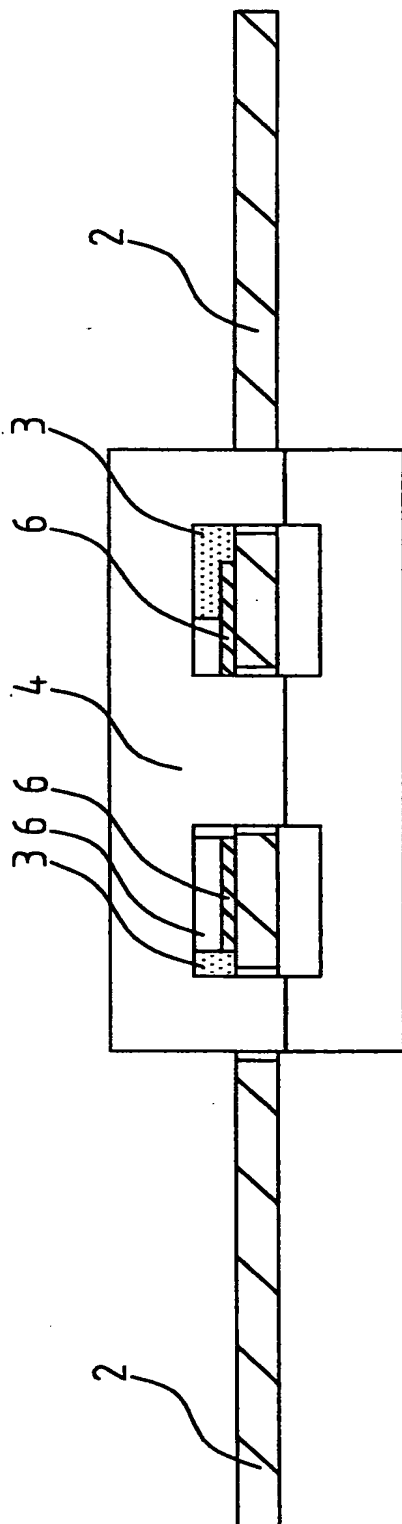


Fig. 2

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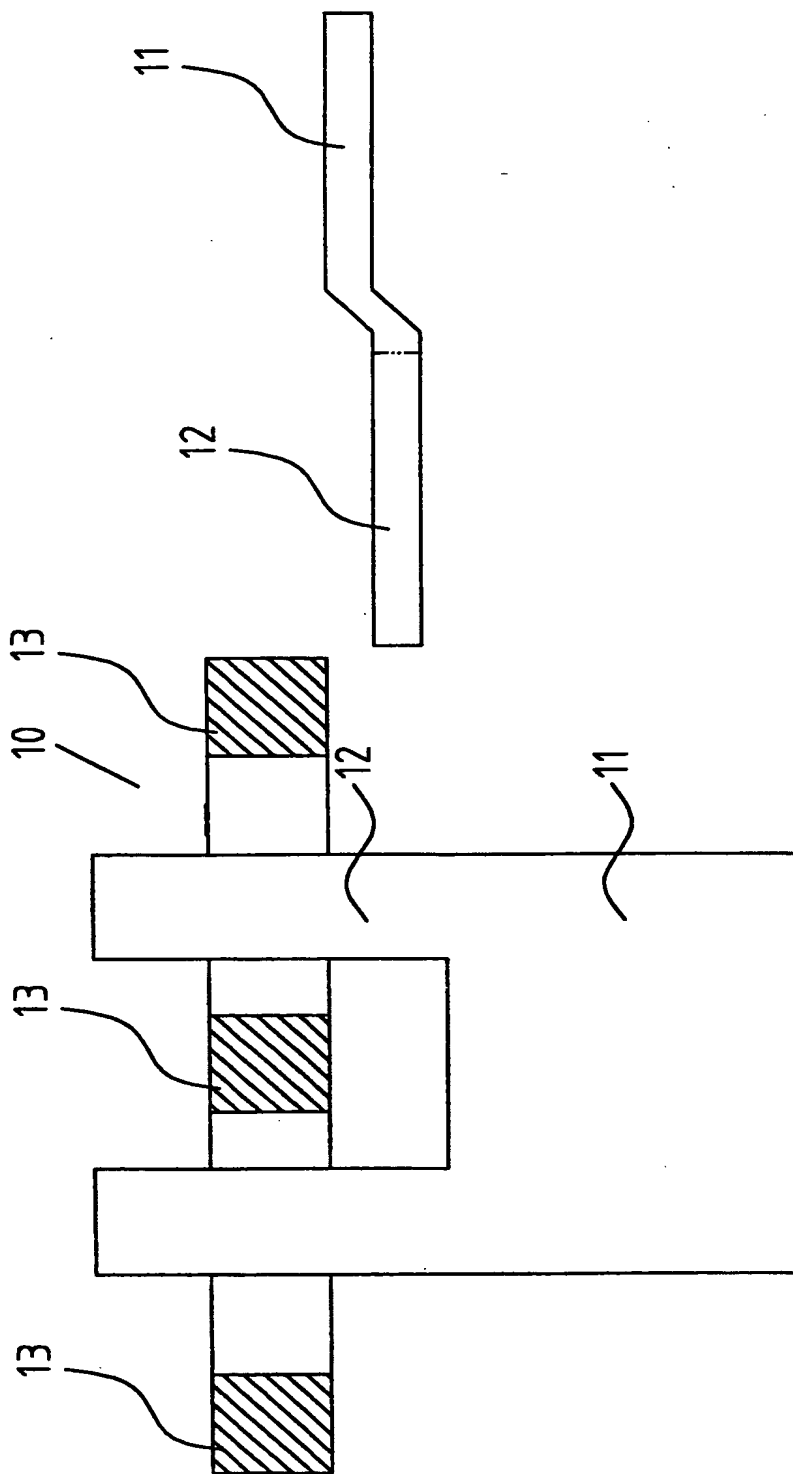


Fig. 3

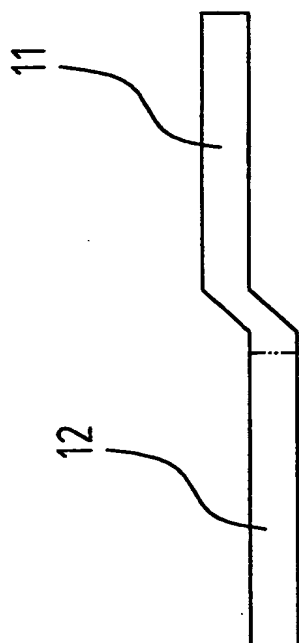


Fig. 4

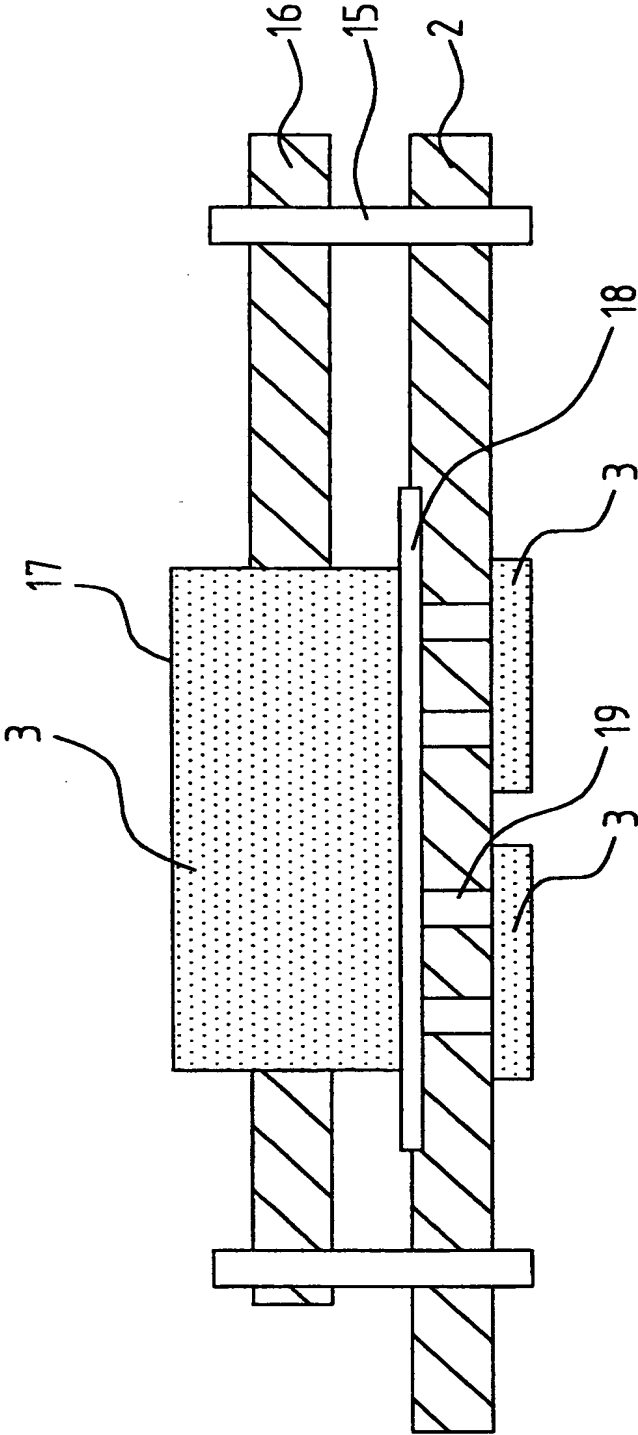


Fig. 5

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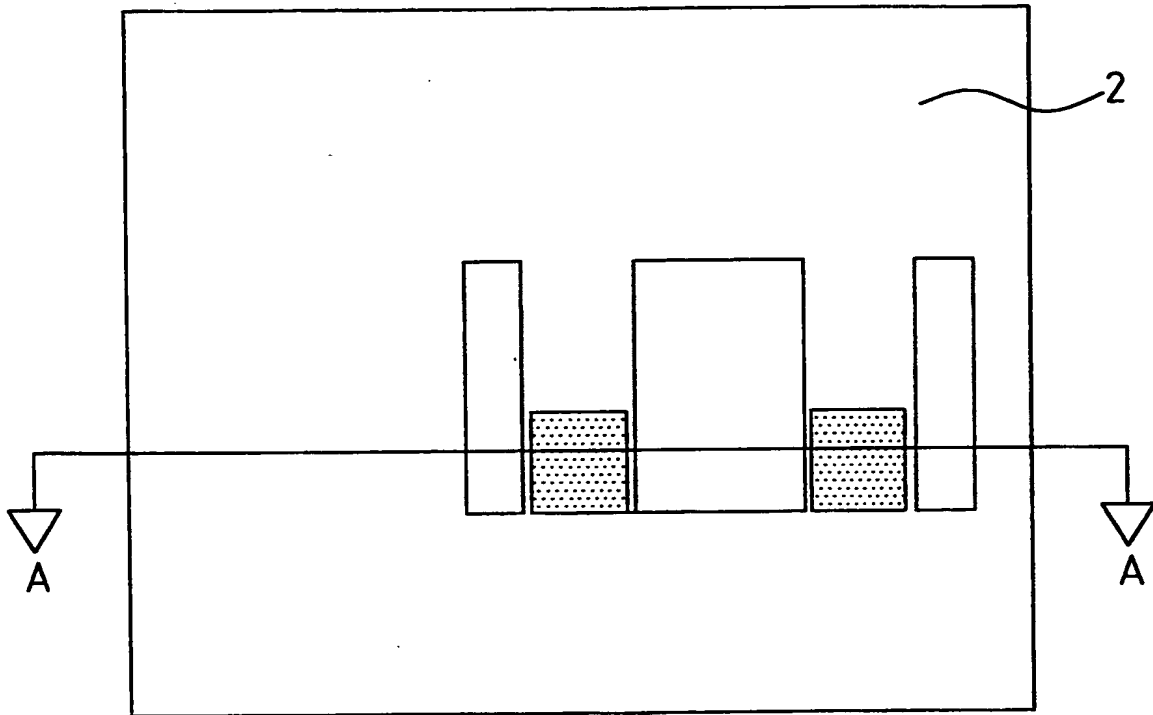


Fig. 6

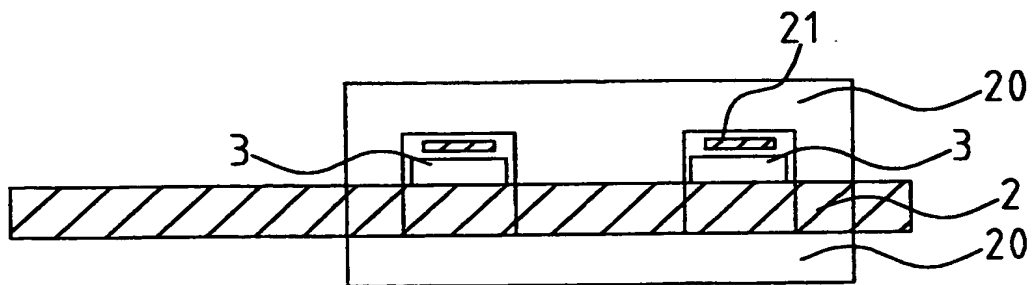


Fig. 7

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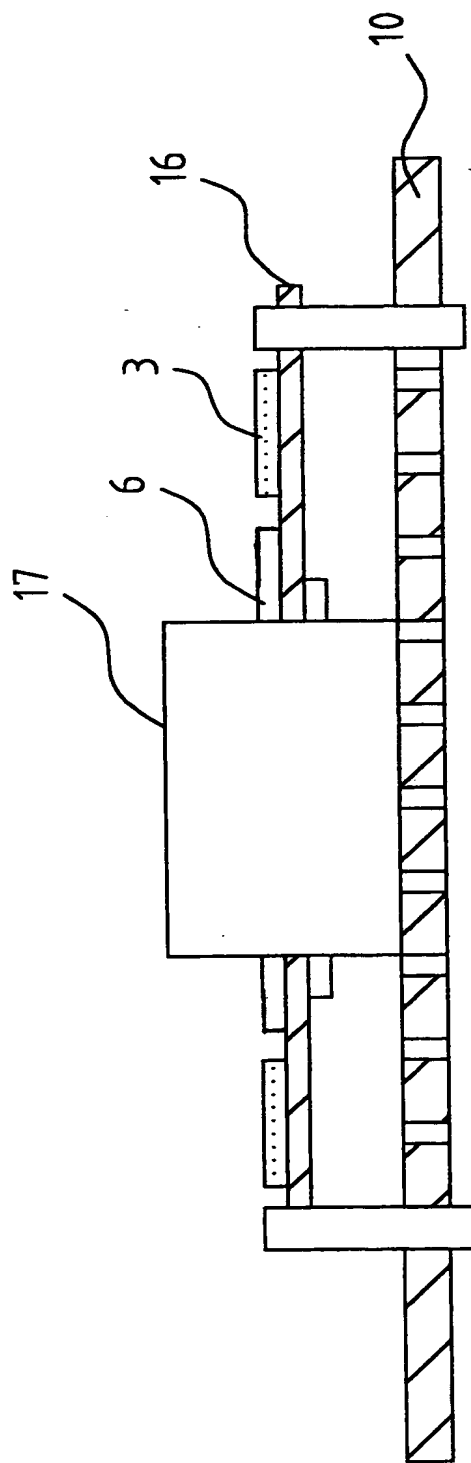


Fig. 8

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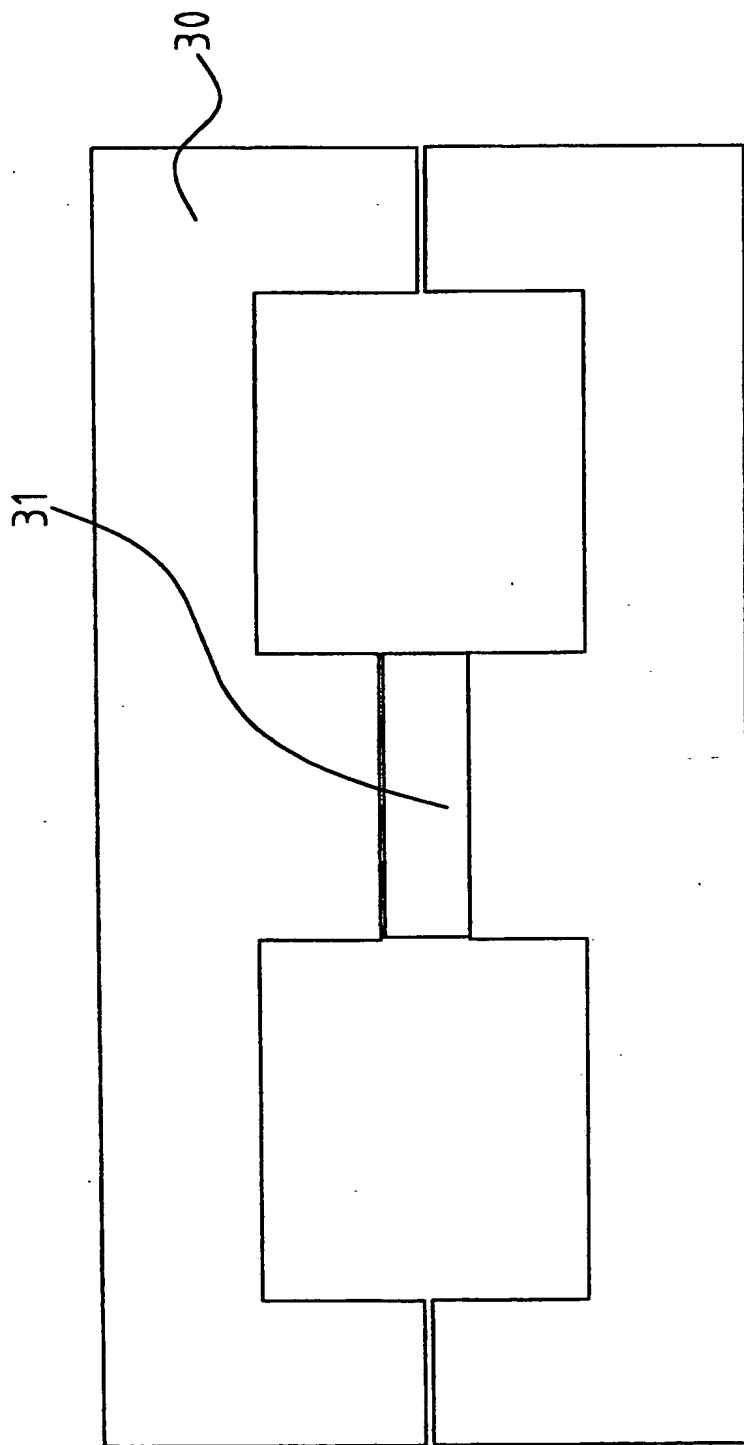


Fig. 9

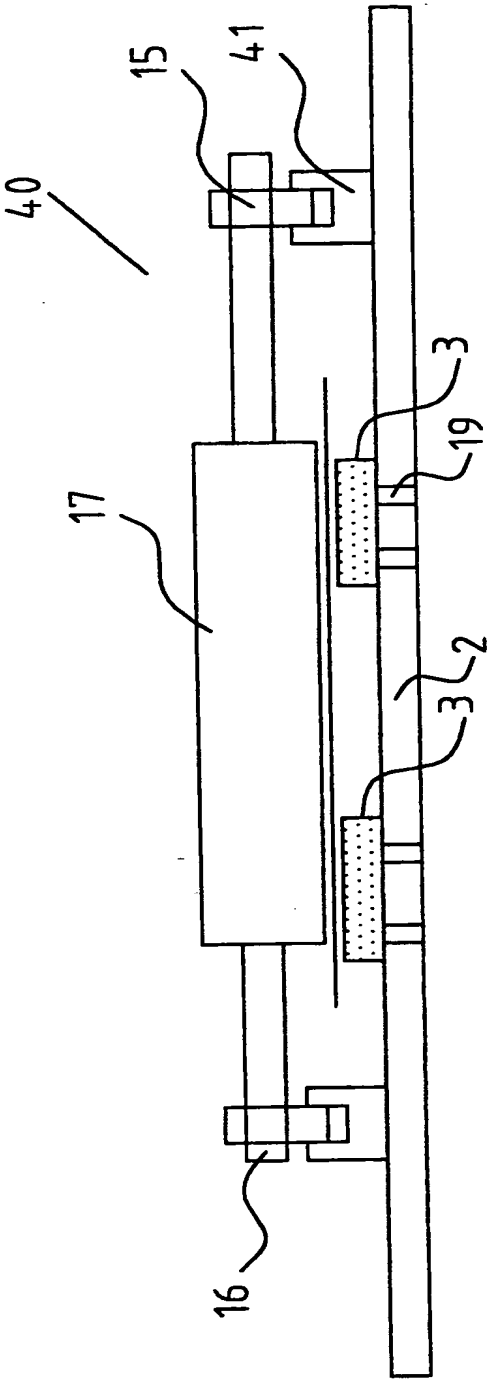


Fig. 10

INTERNATIONAL SEARCH REPORT

Internat. Application No

PCT/IE 00/00106

A. CLASSIFICATION OF SUBJECT MATTER
 IPC 7 H05K1/18 H05K1/14 H05K7/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H05K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 1995, no. 03, 28 April 1995 (1995-04-28) & JP 06 350220 A (TOKYO ELECTRIC CO LTD), 22 December 1994 (1994-12-22) abstract	1-3,8,18
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X	EP 0 856 447 A (SIEMENS AG) 5 August 1998 (1998-08-05) abstract; figures	1-3,18
Y	---	5-7
	-/--	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

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- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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- *G* document member of the same patent family

Date of the actual completion of the international search

24 November 2000

Date of mailing of the international search report

04/12/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
 NL - 2280 HV Rijswijk
 Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
 Fax: (+31-70) 340-3016

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Mes, L

INTERNATIONAL SEARCH REPORT

Internat'l Application No

PCT/IE 00/00106

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	---	20, 21
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INTERNATIONAL SEARCH REPORT

Internat'l Application No

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>PATENT ABSTRACTS OF JAPAN vol. 1996, no. 03, 29 March 1996 (1996-03-29) & JP 07 297048 A (KYOCERA CORP), 10 November 1995 (1995-11-10) abstract</p>	<p>13,14, 20,21</p>

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Internal Application No

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JP 07297048 A	10-11-1995	NONE	

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 30883W0	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/IE 00/ 00106	International filing date (day/month/year) 13/09/2000	(Earliest) Priority Date (day/month/year) 13/09/1999
Applicant COMMERGY TECHNOLOGIES LIMITED et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 4 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.

☒ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

1
☐ None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/IE 00/00106

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H05K1/18 H05K1/14 H05K7/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H05K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 1995, no. 03, 28 April 1995 (1995-04-28) & JP 06 350220 A (TOKYO ELECTRIC CO LTD), 22 December 1994 (1994-12-22) abstract	1-3, 8, 18
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Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Mes, L

INTERNATIONAL SEARCH REPORT

International Application No

PCT/IE 00/00106

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 019 941 A (CRAFT) 28 May 1991 (1991-05-28) claims; figures ---	5-7
X	US 5 079 672 A (HAUBNER ET AL) 7 January 1992 (1992-01-07) claims; figures ---	1-3, 18
X	US 4 803 590 A (FASSEL ET AL.) 7 February 1989 (1989-02-07) abstract; figures ---	1-3, 18
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A	DE 197 07 702 A (SIEMENS AG) 27 August 1998 (1998-08-27) claims; figures ---	13, 14
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Y	---	22, 23
A	EP 0 413 848 A (SIEMENS AG) 27 February 1991 (1991-02-27) claims; figures ---	13
X	---	20
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X	---	20, 21
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INTERNATIONAL SEARCH REPORT

International Application No

PCT/IE 00/00106

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>PATENT ABSTRACTS OF JAPAN vol. 1996, no. 03, 29 March 1996 (1996-03-29) & JP 07 297048 A (KYOCERA CORP), 10 November 1995 (1995-11-10) abstract</p> <p>-----</p>	<p>13, 14, 20, 21</p>

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Information on patent family members

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PCT/IE 00/00106

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			JP 1906250	C	24-02-1995
			JP 6032410	B	27-04-1994
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JP 07297048	A	10-11-1995	NONE		

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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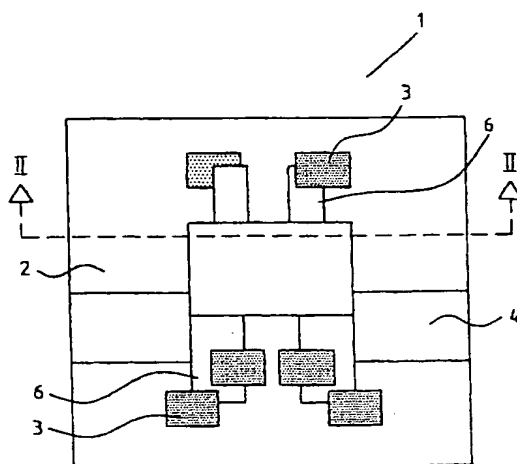
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- (54) Agents: **O'CONNOR, Donal, H.** et al.; Cruickshank & Co., 1 Holles Street, Dublin 2 (IE).
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- (71) Applicant (for all designated States except US): **COM-MERGY TECHNOLOGIES LIMITED** [IE/IE]; 133 Lansdowne Park, Ballsbridge, Dublin 4 (IE).
- (72) Inventor; and
- (75) Inventor/Applicant (for US only): **YOUNG, George** [IE/IE]; 11 Woodlands Park, Blackrock, County Dublin (IE).
- (81) Designated States (*national*): AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DE (utility model), DK, DK (utility model), DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.
- (84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).
- Published:**
— With international search report.
- For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: **A PRINTED CIRCUIT BOARD ASSEMBLY**



(57) Abstract: A PCB assembly (1) in this case a DC-DC converter comprising a single layer board (2), mounts power semi-conductor devices forming high heat generating components (3) and various cores of magnetic material forming heat dissipating components (4). Tracks of heat conductive coupling material (6) lie above or below each heat generating component (3) and project into one of the heat dissipating components (4) and beside the others. In one embodiment, the heat generating components (3) are housed within a heat dissipating component (3). In another PCB assembly, there is an additional plug-in PCB which may itself carry heat generating components (3) or only heat dissipating components (4). In the latter case, the heat generating components (3) are mounted on the PCB assembly below the additional plug-in PCB.

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INTERNATIONAL SEARCH REPORT

Internat. Application No

PCT/IE 00/00106

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H05K1/18 H05K1/14 H05K7/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H05K

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Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Mes, L

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Internat'l Application No

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	DE 197 07 702 A (SIEMENS AG) 27 August 1998 (1998-08-27) claims; figures ---	13, 14
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Y	---	22, 23
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X	---	20, 21
	-/--	

INTERNATIONAL SEARCH REPORT

International Application No

PCT/IE 00/00106

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Internal Application No

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